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Selection of levels of Ingredients for the preparation of milk-coconut sweet based on sensory and instrumental colour attributes

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ABSTRACT

Milk-coconut sweet was developed by combining different proportions of concentrated buffalo milk (40-60 parts), coconut kernel flakes (20-40 parts), sugar (10-30 parts) on the basis of total weight. The raw materials were optimized on the basis of sensory evaluation (flavour, body and texture, colour and appearance, sweetness and overall acceptability) and instrumental colour analysis based on lightness (L*), redness (a*) and yellowness (b*). Incorporation of concentrated milk beyond 60 parts and coconut kernel flakes beyond 40 parts resulted in a crumbly body in milk-coconut sweet. Addition of sugar below 10 and above 30 parts in the milk-coconut sweet led to low and high sweet taste, respectively. Sensory evaluation and colour analysis of the prepared samples revealed that the sweet prepared with 50 parts of milk, 30 parts of coconut flakes and 20 parts of sugar obtained highest scores. The range of concentrated buffalo milk, coconut flakes and ground sugar were selected as 45-55, 15-25 and 25-35 parts, respectively for optimization of milk-coconut sweet.

Key words: Coconut kernel flakes, Colour values, Milk sweet, Sensory evaluation, Sugar.

INTRODUCTION

India is the top most milk producing country in the world with an annual production of 146.3 million tonnes having per capita availability of 322 g/day accounting for 16.3% of the global milk production during 2015-16 (NDDB, 2016). Traditional Indian Dairy Products (TIDP) are country's one of the most profitable and promising segment because of its incredible cultural, religious, social, and economic importance among Indian consumers (Vaghela *et al., 2015*). In India, more than 150 variants of milk based sweetmeats are produced in different regions. Milk-coconut sweet traditionally prepared by heating coconut flakes in milk with sugar in an open pan is quite popular in eastern and southern parts of India.

Coconut often called as 'Tree of life', is a valuable fruit tree in the world, especially in the tropical and subtropical regions (Chan and Elevitch, 2010). India is the third largest coconut producing country, after Indonesia and the Philippines with an annual production of 20440 million nuts (CDB, 2016). Fresh mature coconut is an excellent source of minerals such as copper, calcium, iron, manganese, magnesium and zinc, and a very good source of vitamin B complex such as folates, riboflavin, niacin, thiamine and pyridoxine (Srivastava *et al*., 2011). Bhatnagar *et al*. (2009) reported that coconut oil contains about 93% of saturated fatty acids (SFAs) among which 65% is medium chain saturated fatty acids (MUFAs) of which 50-55% is lauric acid ($C_{12:0}$). These MUFAs do not participate in the biosynthesis and transport of cholesterol as they are directly absorbed from the intestine and passed on to liver to be rapidly metabolized for energy production (Enig, 2004).

The presence of coconut kernel flakes and milk makes milk-coconut sweet a highly nutritious dairy product which may open up a new avenue in TIDP market. Previously a few studies (Rao *et al.,* 1990; Rao *et al.,* 1999; Gupta *et al.,* 2010) were conducted on desiccated coconut based products *viz., holige, modaka, burfi*, respectively which focussed mainly on enhancement of their shelf life. Srivastava *et al.* (2011) standardized the process for the preparation of ready-to-eat sweetmeat, using virgin coconut meal (VCM) or desiccated coconut powder and observed very good compatibility between milk and coconut flavour. Although, the fresh coconut flakes have high nutritive value, a detailed study for its use in the preparation of milk based product has not been carried out yet. The present study was, therefore, conducted to prepare milk-coconut sweet using fresh coconut flakes, buffalo milk and sugar.

MATERIALS AND METHODS

The research work was conducted in the Dairy Technology Division, ICAR- National Dairy Research Institute (NDRI), Karnal, Haryana, India and the pilot scale trials of the product were conducted in the Experimental Dairy of the Institute. Pooled raw buffalo milk collected from the Experimental Dairy was analyzed for fat, solids not fat (SNF) and acidity. Cane sugar and polystyrene cups were obtained from the Experimental Dairy. Good quality mature

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fresh coconuts, desiccated coconut (dried kernel with seed coat i.e. testa/copra) were purchased from local market of Karnal, Haryana. Coconut shredder was procured from the market of Kolkata, West Bengal.

Preparation of raw materials

Coconut flakes, concentrated milk and ground sugar: Coconuts were dehusked manually and were broken into two halves(Fig. 1) followed by careful flaking of coconut kernel using coconut shredder to obtain only the white flakes of coconut. Sugar was ground using a kitchen grinder. Fat, SNF and acidity (% lactic acid) of the milk samples ranged between 6.5-7.8%, 8.5-9.0% and 0.14-0.16%, respectively. The samples were standardized to 6.0% fat and 9.0% SNF using buffalo skim milk and concentrated to 35% of total solids (TS) using a steam heated double jacketed kettle.

Preparation of milk-coconut sweet: Concentrated buffalo milk (TS 35%) was mixed with coconut kernel flakes in an open pan (*karahi*) and scrapped continuously until it reached to a pasty consistency. Ground sugar was added to the paste and the mixture was heated until it reached to a pasty stage so that it could be scraped off the surface of the open pan. The mixture was cooled to room temperature and shaped into balls manually. The prepared product was cooled and packed in polystyrene cups. The proportion of concentrated buffalo milk, coconut kernel flakes and ground sugar used for product preparation ranged between 40-60, 10-30 and 20-40 parts, respectively. The ideal concentration of these ingredients was selected on the basis of sensory evaluation and colour analysis.

Sensory evaluation: The sensory characteristics of milk-coconut sweet were evaluated by a panel of 11 semi trained judges from the faculty of Dairy Technology Division of the Institute. The panelists were dairy professionals having adequate knowledge about the sensory evaluation methods, desirable sensorial attributes and defects of milk products. The samples were evaluated for sensory attributes *viz.,* flavour, body and texture (BT), colour and appearance (CA), sweetness and overall acceptability (OA) using a 9 point Hedonic scale wherein 9 and 1 denote 'liked extremely' and disliked extremely', respectively. In each testing session, two intact pieces of sample (tempered to 25°C) coded with random three digits codes in closed glass container were presented to panel members for providing independent observations on randomized samples (maximum three samples at a time).

Colour analysis: The surface colour of milk-coconut sweet was measured using a "Colorflex" colorimeter supplied by Hunterlab (Hunter Associates Laboratory,Inc., Reston, VA, USA) following the protocol described by Nalwade *et al.* (2014).

Statistical analysis of data: Data obtained in the present study was subjected to analysis of variance (ANOVA) and independent sample t-test. Duncan's post hoc test ($P < 0.05$) was also applied to compare the differences among the mean values. SPSS statistical tool (SPSS, IBM 20.0) was used for analyzing all the data.

RESULTS AND DISCUSSION

Effect of type of milk on the sensory and instrumental colour attributes of milk-coconut sweet: The average scores for different sensory and instrumental colour attributes of the milk-coconut sweet are presented in Table 1. The product made from buffalo milk scored higher for CA (7.73), flavour (7.75), BT (7.23), sweetness (7.86) as well as OA (7.91) than those made from cow milk and mixed milk. This might be due to lower fat and lactose levels in cow milk than buffalo milk. The milk-coconut sweet prepared by using the admixture (40:60) of cow and buffalo milk scored lowest for all the sensory attributes except for CA, score for which was higher than that prepared using cow milk alone. BT score of the sweet prepared using buffalo milk differed significantly ($p < 0.05$) from the samples prepared with cow milk as well as mixed milk. This might be due to the presence of higher levels of divalent cations in buffalo milk, which contributed to its harder BT (Sindhu 1995). Instrumental colour analysis showed that the highest L* (65.82) and a* values (3.20) were observed in the sweet prepared using buffalo milk, followed by mixed milk and cow milk. The absence of β-carotene in buffalo milk and the whiteness of the coconut flakes might have contributed to the higher lightless value to the milk-coconut sweet prepared from buffalo milk. Additionally, the

Table-1: Effect of type of milk on sensory and instrumental colour attributes of milk-coconut sweet (Mean±SE)[1]

Sensory attributes	Type of milk		
	Cow milk	**Buffalo milk**	**Mixed milk**
Flavour	7.21±0.11^{b}	7.75±0.10^{a}	7.54±0.23^{b}
Body and texture	6.82±0.35^{b}	7.23±0.21^{a}	6.77±0.27^{b}
Colour and appearance	6.96±0.23^{b}	7.73±0.12^{a}	7.05±0.20^{b}
Sweetness	7.29±0.27^{b}	7.86±0.19^{a}	7.29±0.36^{ab}
Overall acceptability	7.14±0.18^{b}	7.91±0.20^{a}	7.35±0.22^{ab}
L*	50.63±0.67^{c}	65.82±0.96^{a}	60.72±0.60^{b}
a*	2.40±0.11^{b}	3.20±0.47^{a}	0.75±0.01^{c}
b*	9.19±0.07^{a}	5.25±0.12^{b}	7.95±0.05^{a}

[1] Means with different superscripts within a row differ significantly ($P < 0.05$)

L*: lightness, a*: redness, b*: yellowness

Table 2: Effect of type of coconut on sensory and instrumental colour attributes of milk-coconut sweet (Mean±SE)[1]

Sensory attributes	Type of coconut		
	Desiccated coconut	**Fresh whole coconut**	**White coconut flakes**
Flavour	6.86±0.18 [b]	7.50± 0.19 [a]	7.64± 0.24[a]
Body and texture	6.57±0.2 [c]	7.23±0.21 [b]	8.18±0.19 [a]
Colour and appearance	6.36±0.28 [c]	7.29±0.10 [b]	8.36±0.14[a]
Sweetness	7.00±0.22 [c]	7.57±0.17 [b]	8.07±0.25 [a]
Overall acceptability	6.71±0.18 [c]	7.43±0.17 [b]	8.39±0.15 [a]
L*	45.05±0.19 [c]	50.45±0.51 [b]	70.36±0.11[a]
a*	6.07±0.13 [a]	5.75±0.13 [b]	1.75±0.07 [c]
b*	15.83±0.20 [c]	18.19±0.15 [b]	23.78±0.23 [a]

[1]Means with different superscripts within a row differ significantly ($P < 0.05$)
L*: lightness, a*: redness, b*: yellowness

buffalo milk contains higher amount of fat, which accentuates the scattering of light and thereby contributing to the whiteness of the product. Buffalo milk contains higher amounts of lactose and sulphated amino acids, which contribute to the browning reaction (Kinsella and Whitehead 1989). These factors might be responsible for the higher a* value of milk-coconut sweet prepared from buffalo milk. Among all the samples, b* value was highest in the sweet prepared with cow milk (9.19), which might be due to higher carotenoids present in cow milk (De, 1980). Milk-coconut sweet prepared with cow, buffalo and mixed milk are shown in Fig. 2.

Effect of level of milk on sensory and instrumental colour attributes of milk-coconut sweet: On the basis of preliminary trials, 40-60 parts of buffalo milk was selected for the preparation of milk-coconut sweet. The levels of coconut and sugar were kept constant as 30 and 20 parts, respectively. Both higher and lower levels of milk obtained lower scores for all the sensory parameters (Table 3), probably due to the higher and lower lactose levels, respectively, in milk, which affected the sensory attributes of the product. Higher level of milk produced dark brown colour in the milk-coconut sweet which could be due to the Maillard browning reaction between lactose and lysine amino acid (Boekel, 1998). Lighter colour in samples made from lower level of milk was noticed, probably due to the presence of less lactose in milk. BT score differed significantly ($P < 0.05$) for all three levels of milk. The milk-coconut sweet prepared using 50 parts of milk obtained highest score (7.58) among all samples. Higher than 50 parts of milk produced adverse effect on the BT of the product and consequently scored less. Instrumental colour analysis of milk-coconut sweet showed that with the increase in the levels of milk, the L* value increased significantly ($p < 0.05$) and a* and b* values decreased significantly ($p < 0.05$). Nalwade *et al.* (2014) noticed similar results for cow milk *sandesh*. Therefore, the range of milk was selected as 45-55 parts for further studies and for optimizing the product using RSM.

Fig.-1: Fresh mature white coconut flakes

Effect of type of coconut on sensory and instrumental colour attributes of milk-coconut sweet: Three different forms of coconuts *viz*., desiccated coconut (copra), fresh (shredded whole coconut flakes containing kernel and testa) and kernel flakes (white flakes of kernel as shown in Fig.1) were used in the preparation of milk-coconut sweet to select the best type of coconut based on sensory and colour analysis of the product (Table 2). Among all the samples, milk-coconut sweet prepared with coconut kernel flakes obtained

Table 3: Effect of level of milk on sensory and instrumental colour attributes of milk-coconut sweet (Mean±SE)[1]

Sensory attributes	Level of milk		
	40 parts	**50 parts**	**60 parts**
Flavour	6.62±0.14 [b]	7.83±0.20[a]	[c]6.78±0.24 [b]
Body and texture	6.36±0.15[c]	7.58±0.13 [a]	6.94±0.21 [b]
Colour and appearance	6.64±0.23 [b]	7.75±0.14 [a]	6.61±0.16 [b]
Sweetness	7.10±0.29 [a]	7.10±0.23 [a]	7.10±0.29 [a]
Overall acceptability	6.73±0.23 [b]	7.70±0.15 [a]	6.75±0.27 [b]
L*	51.82±0.25 [c]	66.75±0.21 [b]	70.39±0.26 [a]
a*	2.15±0.02 [a]	2.01±0.02 [b]	1.68±0.01 [c]
b*	23.79±0.28 [a]	23.44±0.31 [a]	19.97±0.23[b]

[1]Means with different superscripts within a row differ significantly ($P < 0.05$)
L*: lightness, a*: redness, b*: yellowness

Fig-2: Milk-coconut sweet prepared with cow milk (a) and buffalo milk (b) and mixed milk (c)

highest scores for CA (8.36), BT (8.18), flavour (7.64), sweetness (8.07) and OA (8.39). The sensory attributes of the products prepared using different forms of coconut differed significantly ($P < 0.05$) from each other. Desiccated coconut and fresh whole coconut particles increased the hardness of the product and also increased the brown particles in coconut testa. The softer and whiter colour of the coconut kernel flakes might be responsible for the higher sensory scores obtained by the product made from it. Instrumental colour analysis showed that highest L* (70.36) was observed in the sample prepared using white flakes of fresh coconut kernel and buffalo milk, both of which are white in colour. Redness value (6.07) was higher in the sample prepared with desiccated coconut which is brownish white in colour due to the presence of coconut testa. Yellowness value (23.78) was higher in the sample prepared with white flakes of fresh coconut kernel and buffalo milk. This could be due to the effect of cooking on the sweet.

Effect of level of coconut flakes on sensory and instrumental colour attributes of milk-coconut sweet: On the basis of initial sensory trials, the concentration of coconut flakes between 20 and 40 parts were found to be ideal for milk-coconut sweet preparation. The levels of milk and sugar were kept constant as 50 and 20 parts, respectively. Samples prepared with 30 parts of coconut flakes obtained highest score for CA (7.96), flavour (7.73), BT (7.91) and OA (7.83) and differed significantly ($p < 0.05$) from the samples prepared with 20 and 40 parts. Higher levels of coconut flakes inhibited the binding of the product, whereas lower levels increased the hardness. Instrumental colour analysis of milk-coconut sweet also showed that as the level of coconut flakes increased, L* value increased ($p < 0.05$) while a* and b* values decreased significantly ($p < 0.05$)(Table 4). These findings are in agreement with the observations of Kapre *et al.* (2015) on fig *burfi*. BT and OA scores of wood apple *burfi* decreased significantly ($P < 0.05$) due to addition of wood apple at low (5%) and high (15%) levels when compared with 10% level (Nawale *et al.,* 2014). A level of 25-35 parts of coconut kernel flakes was, therefore, selected for conducting further studies to optimize the process parameters for milk-coconut sweet using RSM.

Effect of level of sugar on sensory and instrumental colour attributes of milk-coconut sweet: On the basis of preliminary trials, levels of 10-30 parts of sugar were selected for the preparation of milk-coconut sweet. The levels of milk and coconut flakes were kept constant at 50 and 30 parts, respectively. Sample prepared with 20 parts of sugar obtained highest score for CA (7.89), BT (8.17), sweetness (8.00) and OA (7.94), and differed significantly ($P < 0.05$) from the samples prepared using 10 and 30 parts of sugar (Table 5). The present results on the effect of sugar levels on the quality of milk-coconut sweet agreed well with the findings of Hirpara *et al.* (2013) who reported a consistent increase in colour and appearance score of *Thabdi peda* when the sugar level was increased from 6.0 to 10.0%. The authors concluded that the sugar plays an important role in the colour

Table 4: Effect of level of coconut flakes on sensory and instrumental colour attributes of milk-coconut sweet (Mean±SE) [1]

Sensory attributes	Level of coconut		
	20 parts	**30 parts**	**40 parts**
Flavour	7.62±0.13 [b]	7.73±0.17 [a]	7.58±0.15 [b]
Body and texture	7.00±0.20 [b]	7.91±0.16 [a]	7.00±0.26 [b]
Colour and appearance	7.36±0.25 [b]	7.96±0.17 [a]	7.36±0.25 [b]
Sweetness	7.86±0.15 [a]	7.64±0.17 [a]	7.50±0.17 [a]
Overall acceptability	7.22±0.20 [b]	7.83±0.19 [a]	7.14±0.11 [b]
L*	69.21±0.19 [a]	67.93±0.12 [b]	65.12±0.55 [c]
a*	2.66±0.04 [a]	2.11±0.03 [b]	2.08±0.02 [b]
b*	23.97±0.18 [a]	23.84±0.13 [a]	22.03±0.13 [b]

[1]Means with different superscripts within a row differ significantly ($P < 0.05$)

L*: lightness, a*: redness, b*: yellowness

Table 5 Effect of level of sugar on sensory and instrumental colour attributes of milk-coconut sweet (Mean±SE) [1]

Sensory attributes	Level of sugar		
	10 parts	**20 parts**	**30 parts**
Flavour	7.48±0.23[c]	7.72±0.19[b]	8.11±0.16 [a]
Body and texture	7.19±0.19 [b]	8.17±0.22 [a]	7.33±0.14 [b]
Colour and appearance	7.44±0.24 [b]	7.89±0.32 [a]	7.39±0.26 [b]
Sweetness	7.28±0.22 [b]	8.00±0.20 [a]	7.06±0.23 [b]
Overall acceptability	7.31±0.18 [b]	7.94±0.27 [a]	7.28±0.15 [b]
L*	75.07±0.36[a]	68.98±0.31[b]	52.65±0.36[c]
a*	0.70±0.04 [c]	2.57±0.02 [b]	4.99±0.05 [a]
b*	14.56±0.43 [c]	23.33±0.05 [b]	26.84±0.34 [a]

[1]Means with different superscripts within a row differ significantly (P <0.05)

L*: lightness, a*: redness, b*: yellowness

development and sweetness of the product. Lower levels of sugar in milk-coconut sweet resulted in pale colour, whereas higher levels turned it too red, which was disliked by the panelists. Highest score for flavour was obtained by the product prepared using highest level of sugar (30%). The judges liked the cooked flavour of the product, but awarded highest OA score to the product made with 20 parts of sugar. Instrumental colour analysis of milk-coconut sweet revealed that as the level of sugar increased, L* value decreased significantly ($p < 0.05$) while a* and b* values increased significantly ($p < 0.05$). Chetana *et al.* (2010) stated that sugar not only provides sweetness but also retains moisture, lowers water activity and influences texture development of traditional sweets through adhesion and binding properties. At lower levels of sugar, binding of the milk-coconut sweet was not good and at higher level, the product became too hard and chewy. Based on RSM, a range of 15-25 parts of sugar was, therefore, selected for the preparation of a good quality milk-coconut sweet.

CONCLUSIONS

Investigations were carried out to select the type and optimum levels of ingredients for the production of milk-coconut sweet. Product containing 50 parts of concentrated milk, 30 parts of coconut flakes and 20 parts of sugar scored highest for all the sensory attributes. Instrumental colour values of the product also validated the sensory scores. The range for concentrated buffalo milk, coconut flakes and ground sugar were, therefore, selected as 45-55, 15-25 and 25-35 parts, respectively, for the proposed optimization studies of the product using RSM.

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